Effectiveness of Telemedicine Interventions in the Management of Type 1 Diabetes

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Abstract
Introduction: The purpose of this study was to offer an updated global view of the scientific literature regarding the efficacy of type 1 diabetes mellitus telemedicine interventions. *Material and Method:* Articles retrieved from a PubMed Central search query. Information on biological and psychological parameters of these interventions was retained, sorted and analyzed. *Results:* The obtained results revealed that certain intensive approaches produced significant change in monitored parameters: increase in glycaemic control and in subjective parameters of psychological control over this condition. However, a segment of the studies taken into consideration noted poor results in some-or all-parameters taken into consideration. *Conclusion:* Our results highlights that however promising, these interventions still require significant focus and energy to become effective and thus useful for diabetic patients in a clinical setting.

Keywords: Telemedicine; HbA1c (glycated haemoglobin test); Diabetes mellitus, Type 1; m-health

Introduction

Telemedicine is defined as "the use of telecommunication to support health care"[1] and presents itself as a promising concept to increase the availability of healthcare in the future. It is characterized by a timely transmission of raw medical data, remote interpretation coupled with follow-up and preventative measures. One of the most avid fields for frequent follow-up is that of chronic conditions (such as diabetes, hypertension, inflammatory bowel disease) with potentially life-threatening complications. One of the candidates to match the criteria is type 1 diabetes mellitus. Type 1 diabetes, an autoimmune condition where the insulin-secreting cells of the pancreas are destroyed by autoantibodies, is usually diagnosed at an early age (usually in childhood, adolescence or early adulthood), when patients require careful follow-up [2]. At this age, patients are inclined towards the use of smartphones and other gadgets [3]. As such, this condition presents itself as ideal for pioneering e-health programs.

However, preliminary results [3–6] published highlight some issues with applying this type of intervention to real-life practice. These reports range from excellent-results of individual studies [7–10] to poor-as reported by systematic reviews [3,11,12]. Several researchers showed that this type of intervention have significant weaknesses that do not support applying the method on a larger scale such as the entirety of type 1 diabetes patients treated in any given clinic [13,14]. Furthermore,

certain studies focus on both type 1 and type 2 diabetes, with focus on the more prevalent condition (type 2 diabetes mellitus) [15]. Clear results are needed for both conditions, but in distinct, clearly-aimed projects. Our aim was to offer a summary of the current literature on the subject of telemedicine interventions in type 1 diabetes mellitus, with regards to their effectiveness as reflected by biological and psychological parameters.

Method

The current study was done using PubMed Central (PMC) search carried out on 04/06/2016 for the terms:

((telemedicine) AND compliance) AND (diabetes type 1)

Articles which presented telemedicine intervention results on type 1 diabetes were taken into consideration. Inclusion criteria were: articles available in English, with available abstracts, which presented findings from interventions on type 1 diabetes specifically. Both original research and review articles were taken into consideration. Full text articles were retrieved where possible. Exclusion criteria were: article published in other languages, missing or broken links, articles which presented intervention results on type 1 and type 2 diabetes in a clustered fashion(without defining the exact results on type 1 diabetes). The articles which met inclusion criteria were analyzed.

The results retrieved from the PMC literature search are detailed in Figure 1.

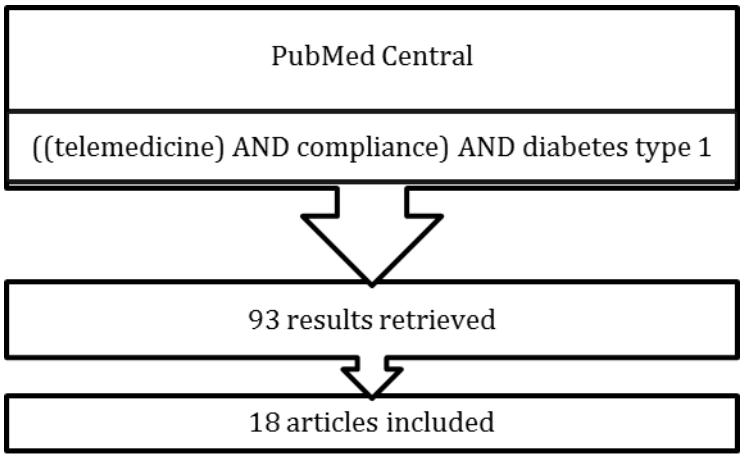

Figure 1. Search method and selection of relevant literature segment

The manuscripts were organized according to the type of research paper as reviews or original article. The following information was selected and retained: the technological means of implementing the intervention, improvements in glycaemic control as quantified by HbA1c levels, the acceptance level, subjective parameters accompanying the intervention, and finally, the overall assessment of the method in terms of feasibility and usefulness.

Technological Means of Approaching Patient Care

Two major categories of interventions were observed: intervention platforms which functioned as trackers on mobile devices, with manual input of data and systems which connected medical devices (such as glucometers, insulin pumps) to an application or software.

For the class of resources with manual data input, logbooks were a popular and ubiquitous choice [4,6,7,9], with a vast majority being mobile phone-based apps. These resources typically offered carbohydrate intake calculators, body mass index calculators, chatrooms [5] and direct contact with a trained professional [5,7,8] via text messages, phone calls or internet based

messaging services.

As far as connective technology is concerned, the articles are scarce numerically, however they offer ideas with regards to: a screening program for diabetic retinopathy [13] with a resolution time per case of 12 min 53 seconds, which used specialized software and a camera to register, grade and track cases, as well as a system [14] incorporating a hypoglycaemia prediction algorithm with a mobile GPS and SMS service, automatically notifying emergency services in case of extreme hypoglycaemia.

Improvements in Glycaemic Control Reflected in HbA1c Levels

While some interventions [7,9,10] noted a decrease in HbA1c levels ranging from 2.7% to 0.4%, a segment of literature indicated that the decrease in HbA1cwas not statistically significant (e.g. 7.9 to 7.5) [1,3,15].The decrease in this parameter was noticed in more complex programs, where real-life involvement was also a component in the care plan. The efficiency of these plans increased alongside their complexity and integration of data from insulin pumps and glucose monitors [19]. Interventions based around apps or mobile resources were similar to the control method (i.e. the use of a paper based journaling technique).

Subjective Measures of Efficiency: Impact on Quality of Life, Acceptance of Program

These novel methods of journaling a patient's progress(such as apps or websites which aid in tracking food intake, glucose levels, check-ups and other significant parameters) in managing type 1 diabetes have been noted as being fairly well accepted [9], helpful in aiding in good decision-making, ensuring self-efficiency and adherence [4,15]. As a subjective measure, the parents of the subjects included in the intervention reported an increase in adherence to the treatment plan[9]: better dietary control, compliance with insulin dosage and monitoring of symptoms. However, a segment of literature reports no significant difference in overall quality of life as well as specific parameters such as diabetes-related anxiety, self-efficiency, or increase in frequency of self-monitoring [7,6].

Overall Assessments of Telemedicine Interventions

Telemedicine interventions in the management of type 1 diabetes are relatively heterogenous in their aims and approach: their purpose is to offer the patient effective tools for the control of their condition. The interventions have been deemed as promising [1,16–18], with some modest results being justified as a result of too-small, undiverse study groups [18], or technology connectivity gaps [10]. However, the evidence to indicate their superiority to the traditional support network for type 1 diabetes(written journals, personal meetings with professionals) was considered weak [12].

The feasibility of some of these projects was still under debate [16,19]. Some of these projects were useful to provide medical care in contexts where accessibility is poor, such as emergency situations, routine screening of diabetic retinopathy, and facilitating access to psychological care for patients with such comorbidities. Individual interventions appeared to be more effective [20].

A significant mention was the development of the GPS/SMS hypoglycaemia alert service [14]. While being a useful tool in the present conditions of insulin therapy, this service would prove priceless in adding a safety layer to the development of the artificial pancreas [14].

Limitations

The present literature search was conducted on the NCBI NIH search which yielded the most results, namely the PubMed Central search query.

The current paper could benefit from a statistical analysis of the outcomes of these studies. However the approaches and scopes are so varied among a small body of literature that the results would be disparaged at best.

In order to apply these techniques on a larger scale and have patients benefit from them, more approaches need to be sustained by studies; furthermore, longer-spanning studies are required to assess the efficiency of these methods once the novelty wears off.

However attractive, telemedicine in the routine follow-up and control of type 1 diabetes is in its initial state, with more research being required to clarify the means and goals of the interventions, as well as refine the technical hindrances and reveal long-term efficiency. Thus far, certain interventions have proven their efficacy and established a place for telemedicine interventions in future patient care.

List of abbreviations

HbA1c = glycated haemoglobin
GPS = global positioning system
SMS = short message service
App = application, used for mobile phone/tablet; a type of software

Conflict of Interest

The authors declare that they have no conflict of interest.

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